

Use of Distiller's Grains (Wet & Dry) in Flaked Corn Diets for Finishing Beef Cattle

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Abstract

One hundred and eighty mixed steer calves (898 ± 62 lb) were blocked by weight (six blocks) and randomly allotted into six head pens to evaluate inclusion of distillers grain in flaked corn finishing diets. Treatments were: 1) steam flaked corn control finishing diet, or inclusion of 2) 10% dry distillers grains, 3) 10% wet distiller's grains, 4) 20% wet distiller's grains, or 5) 30% wet distiller's grains. All diets contained 8.0% chopped alfalfa and inclusions replaced flaked corn. Cattle averaged 123 days on feed with a range of 101 to 143. There was no difference ($P > 0.11$) in final body weight, average daily gain, or dry matter intake which averaged 1365.4 lb, 3.83 lb/d, and 23.01 lb, respectively. There was no difference ($P > 0.12$) in carcass weight, dressing percentage, fat thickness, kidney pelvic heart fat, rib eye area, or yield grade which averaged 887 lb, 64.96%, 0.52 in, 2.36%, 14.01 sq in, and 3.15, respectively. Feed efficiency calculated with final live weights shrunk 4% resulted in a treatment tendency ($P = 0.06$) with a linear decrease ($P = 0.05$) as level of wet distillers grains increased. Feed efficiency calculated with carcass adjusted final weights resulted in no treatment affect ($P = 0.32$) with an average of 6.02 lb of DMI per lb of gain. Marbling score resulted in a treatment difference ($P = 0.03$) where the contrast of control diet (384) vs inclusion of 10% dry distillers grain (416) was significant ($P < 0.02$). For marbling score, contrast of inclusion of 10% dry vs 10% wet distillers grains, linear wet distillers grain level and quadratic wet distillers grain level were not significant ($P > 0.23$). The average marbling score was 392. This experiment indicates that inclusion of up to 10% dry or 30% wet distillers grains into steam flaked corn finishing diets did not result in any consistently detectable influence on animal performance or carcass characteristics. However, numerical trends were similar to results observed by other researchers. These data suggest that distiller's grains contain approximately 86% the energy of steam flaked corn.

Key Words: cattle, feedlot, flaked corn, wet distiller's grains, dry distiller's grains

Introduction

As the U.S. ethanol industry continues to expand, the availability of by-products generated from milling processes will increase. Current and planned ethanol plant constructions within about 100 miles of the Oklahoma panhandle could eventually produce about 500 million gallons of ethanol per year. Along with ethanol, about 5 million tons of wet distiller's grains (33% dry matter) will be produced per year (~13,700 tons/day). Therefore, there will be tremendous opportunity for Oklahoma cattle feeders to take advantage of and use this by-product in their operations. The majority of the research evaluating the use of distiller's grains in feedlot rations has been done with dry-rolled corn (DRC) or high-moisture corn (HMC) based diets in the northern Great Plains, whereas, most feedyards in the southern Great Plains feed steam-flaked corn (SFC) based diets. In Nebraska research, Vander Pol et al. (2006b) fed yearling steers (773 lb initial weight) 0, 10, 20, 30, 40, or 50% (DM basis) of corn wet distiller's grains plus solubles (WDGS) in DRC/HMC (1:1 ratio) based diets. WDGS improved performance at all inclusion levels with the optimum response occurring with 30 to 40% WDGS which improved feed efficiency 11 to 13%. In an additional

experiment, Vander Pol et al. (2006a) evaluated the effects of six corn processing methods in feedlot diets containing 30% WDGS (DM basis) fed to yearling steers (701 lb initial weight). Treatments consisted of whole corn, DRC, DRC/HMC mix, SFC and fine ground corn. Results indicated that there was a performance advantage when feeding WDGS with corn processed as either dry-rolled or high-moisture. In contrast, cattle fed SFC did not gain or convert as well as expected.

Some evidence suggests that the optimum inclusion level is considerably lower than 40% for diets based on SFC. Daubert et al. (2005, Kansas State University) fed heifers (849 lb initial weight) 0, 8, 16, 24, 32 or 40% sorghum WDGS in diets based on SFC. Although heifers were only fed for 58 days, feed efficiency was improved 9% for heifers fed 16% WDGS and efficiency became similar to the control heifers after diets contained more than approximately 24% WDGS. In the southern Plains (Texas Tech University), Vasconcelos et al. (2007) fed feedlot steers (889 lb initial weight) diets containing 0, 5, 10, or 15% sorghum WDGS or 10% corn WDGS (DM basis) in SFC based diets. In contrast to previous studies which reported improved daily gains and feed efficiency in cattle fed WDGS, there was a linear decrease in both gain and efficiency with increasing sorghum WDGS concentration. There was no difference in performance between steers fed 10% sorghum WDGS or 10% corn WDGS.

Additional Nebraska research (Corrigan et al., 2007) fed feedlot steers (692 lb initial weight) WDGS at 0, 15, 27.5, or 40% of the diet (DM basis) in DRC, HMC and SFC based diets. Optimal feedlot performance was observed with 40%, 27.5%, and 15% WDGS in DRC, HMC, and SFC based diets, respectively. These researchers concluded that a greater response to WDGS was observed with less intensely processed corn. Additional Kansas research (May et al., 2007) evaluated feeding feedlot steers (997 lb initial weight) WDGS at levels of 0, 10, 20, or 30% (DM basis) in DRC and SFC based diets. In this trial, adding WDSG to DRC based diets improved performance, whereas, adding WDSG to SFC based diets appeared to reduce performance.

In summary, data evaluating the use of corn WDGS in SFC based feedlot diets suggest that the optimal inclusion level may be less than that observed with other forms of processed corn. With the anticipated construction of primarily corn ethanol plants in the southern Great Plains and thus, increased availability of distiller's grains, additional research evaluating the use of increasing levels of corn WDGS in SFC diets is needed. In addition, since feedyards in the Southern Great Plains tend to be larger than yards in the Northern Great Plains, management concerns with the feeding of WDGS may differ.

The objectives of this experiment were to determine effects of feeding high levels of WDGS in SFC diets and compare a lower level of WDGS to a similar level of dry distiller's grains plus solubles (DDGS) that is representative of current feeding practices in the region.

Material and Methods

On April 17 and 21, 2007, 157 crossbred yearling steers (initial BW = 886 ± 59.9 lb) and 50 crossbred yearling steers (869 ± 63.2 lb), respectively, were received at the Henry C Hitch feedyard in Guymon, OK. On arrival, each animal was individually weighed, ear tagged, and treated for internal and external parasites with Dectomax Injectable (Pfizer Animal Health, Exton, PA), vaccinated with Bovi-Shield Gold 5 (IBR, BVD Types 1 and 2, PI3, BRSV; Pfizer Animal Health, Exton, PA) and 7 Guage (*Clostridium chauvoei-septicum-novyi-sordellii-perfringens* types C & D bacterin toxoid; Boehringer Ingelheim Vetmedica Inc.; St. Joseph, MO for Walco International), and implanted with Component TE-S with Tylan (120 mg of trenbolone acetate and 24 mg of estradiol with 29 mg of tylosin tartrate; manufactured for VetLife by Ivy Laboratories, Overland Park, KS). All cattle were placed in a single pen and fed a diet containing 29.4% HMC, 19.6%

SFC, 20% chopped alfalfa, 15% corn silage, 9.7% DDGS, 4.3% pelleted supplement, and 2% fat (DM basis).

On April 30, 2007, 180 steers were sorted off from the original 207 head based on initial weight, behavior, and health to be used in this trial. These 180 steers were shipped to the Oklahoma Panhandle State University farm at Goodwell, OK on May 3, 2007. The steers were weighed on two successive days (May 3 and 4; 898 ± 59.7 lb, 3% pencil shrink), blocked by weight and randomly allotted to 30 pens (six hd/pen). Five treatments were randomly assigned to pens within each block. The five dietary treatments (Table 1) were: 1) steam flaked corn control finishing diet (CON), or inclusion of 2) 10% dry distillers grains (D10%), 3) 10% wet distillers grains (W10%), 4) 20% wet distillers grains (W20%), or 5) 30% wet distillers grains (W30%). All diets contained 8.0% chopped alfalfa and inclusions replaced SFC. All diets were balanced to contain a minimum of 13 percent crude protein and meet 105% of the estimated degradable intake protein requirement. The WDGS was obtained from an ethanol plant in Oakley, KS and stored in plastic silage bags for the duration of the experiment. At the time the WDGS was produced, the plant was receiving about 70% corn and 30% sorghum. The SFC (28 lb/bu) was picked up two to three times per week at the Henry C Hitch feedyard and stored in a commodity bay.

On the first two days of the trial (May 4 and 5), the cattle were fed the same diet that they were fed at the feedyard. On day 3, the cattle were adapted to the final diets by sequentially feeding 32, 24, and 16% alfalfa diets for five days each. Cattle were fed twice daily (0630 and 1430) in quantities sufficient to ensure ad libitum consumption. Feed bunks were evaluated visually each day of the experiment at 0630 to determine the quantity of feed to offer each pen. The bunk management strategy was designed to allow for 0 to 2 lb of feed remaining at the time of evaluation. Samples of WDGS and SFC were collected two to three times per week for DM analysis in a 105°C forced air oven for three hours.

Cattle were weighed individually (full weights) at 28-d intervals. All weights are presented with a 4% pencil shrink. Four steers were removed from the trial during the feeding period for reasons unrelated to the experimental treatments (two cripples and two hard breathers). When the block was expected to have an average backfat thickness of 0.5 inches based on visual appraisal, cattle were shipped approximately 134 miles to an Excel Beef slaughter facility in Dodge City, KS. The trial ended on d 101 for two blocks, d 130 for three blocks and d 143 for the last block. On each of these days, the cattle were shipped to the slaughter facility. Carcass data were obtained by personnel from Oklahoma State University. Carcass measurements included hot carcass weight (HCW), longissimus muscle (LM) area, marbling score of the LM, percentage of kidney, pelvic and heart fat (KPH), backfat thickness, calculated USDA yield grade, and USDA quality grade. Dressing percent (average = 64.96%) was used to calculate carcass-adjusted final body weight from HCW and to subsequently calculate carcass-adjusted ADG and feed/gain ratio (F:G).

The quantity of feed offered was recorded daily throughout the trial. At the end of each weigh period, feed bunks were swept, and any remaining feed was weighed and subtracted from the total quantity of feed offered to the pen. Pen records for average body weight and feed consumption were used to calculate ADG, DMI, and F:G for each weigh interval and for the total duration of the trial.

Statistical Analysis

Data were analyzed as a randomized complete block design using the MIXED procedure of SAS (SAS Institute Inc., Cary, NC). Variables included were BW, DMI, ADG, F:G, HCW, carcass adjusted variables (calculated using carcass-adjusted final BW which is equal to HCW divided by the average dressing percent), and other carcass traits. Pen was the experimental unit for all

analyses. The model statements included the fixed effect of treatment and the random effect of block. Data for steers not completing the trial were removed prior to analyses. The following pre-planned contrasts were evaluated: 1) response to increasing levels of WDGS (linear and quadratic), 2) comparison of D10% vs. W10%, and 3) CON vs. D10%.

Results and Discussions

The effects of feeding distiller's grains on steer performance are presented in Table 2. Final body weight averaged 1365 lb. Body weight on d 84 decreased linearly with increasing levels of WDGS ($P = 0.03$). Feed treatment tended to effect final body weight ($P = 0.11$) with body weight tending to decrease linearly as level of WDGS increased ($P = 0.09$). No differences in carcass adjusted final body weight were observed. Feed treatment tended to effect overall ADG on a live BW basis ($P = 0.15$) with a tendency for ADG to decrease linearly as level of WDGS increased ($P = 0.14$). Overall ADG averaged 3.83 lb/d. Treatment did not affect DMI (overall DMI averaged 23.01 lb/d). Feed efficiency over the first 84 d on feed was altered by treatment ($P = 0.01$) with a linear decrease as level of WDGS increased ($P = 0.005$). Feed conversion calculated with final live weights resulted in a linear increase in the amount of feed required per pound of gain ($P = 0.05$) as level of WDGS increased (average of 6.02 lb of DMI per lb of gain). Feed conversion calculated with carcass adjusted final weights resulted in no treatment effect.

The effects of feeding distiller's grains on carcass characteristics are presented in Table 3. There was no treatment difference in HCW, dressing percentage, fat thickness, KPH, or USDA yield grade. Treatment tended to affect LM area ($P = 0.12$) with a linearly tendency for LM area to decrease with increasing levels of WDGS ($P = 0.05$). The average LM was 14.05 sq in. Marbling score resulted in a treatment difference ($P = 0.03$) where the contrast of CON (384) vs D10% (416) was significant ($P < 0.02$). For marbling score, contrast of D10% vs W10%, linear WDGS level and quadratic WDGS level were not significant. The average marbling score was 392. The percent of carcasses grading USDA choice tended to be influenced by treatment ($P = 0.06$) with the comparisons of D10% vs W10% ($P = 0.08$: 59.4 vs 38.9%) and CON vs D10% ($P = 0.05$: 36.1 vs 59.4%) approaching significance. Level of WDGS had no effect on the percent of carcasses grading choice.

The effects of feeding distiller's grains on net energy values of the diet are shown in Table 4. Net energy values of each diet were calculated from actual performance data and intakes using generalized quadratic formulas based on Beef NRC (2000) equations. Using the calculated net energy values of the control diet and book values for energy for the alfalfa and the supplement, net energy values for the SFC were determined by difference. The net energy values for the SFC calculated in this manner were 1.041 and 0.720 Mcal/lb for NEm and NEg, respectively. These values are similar to those reported in the Beef NRC (2000) of 1.057 and 0.735 Mcal/lb for NEm and NEg, respectively. These calculated net energy values for the SFC and the book values for the alfalfa and the supplements were then used to calculate the energy contents of the various diets excluding the distiller's grains. The difference between these energy values excluding distiller's grains and the previously calculated energy values (based on performance and NRC equations) was then divided by the proportion of distiller's grain in the diet to determine the energy content of the distiller's grains. These data suggest that the NEg content of distiller's grains is approximately 86% that of SFC. This value is similar to that observed by Texas researchers. Texas A&M data from Bushland (MacDonald, 2008) suggest the NEg content of WDGS is 99.8% of SFC when 20% WDGS is fed in SFC based diets. Data from West Texas A&M University (Brown and Cole, 2008) suggest the NEg content of WDGS 81% of SFC when 15% sorghum WDGS is fed in SFC based diets. In contrast, Nebraska research (Vander Pol, et al., 2006b) suggested the energy value of

WDGS relative to HMC/DRC (1:1 ratio) was 121 to 178% when fed at levels of 0, 10, 20, 30, 40, or 50% (DM basis). In this research, the energy value of WDGS decreased as dietary inclusion rate increased from 10 to 50%. These data clearly suggest that the value of WDGS is considerably lower when fed in SFC based diets as compared to DRC or HMC based diets.

In summary, significant differences in performance were not observed. However, the observed numerical trends in ADG, DMI, and feed efficiency were similar to that observed by other researchers (Figure 1 to 3). These data and other data suggest that the optimal level of WDGS in steam flaked corn based is about 10 to 15%. Feeding increasing levels of WDGS appear to reduce the performance of feedlot cattle (ADG and feed efficiency). In this experiment, feeding 10% DDGS appeared to improve marbling scores and thus, increase the percent of carcasses grading USDA choice compared to the control treatment. Feeding levels of WDGS up to 30% had no effect on marbling or resulting USDA quality grade. These data suggest that distiller's grains contain approximately 86% the energy of SFC.

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Table 1. Composition and formulated nutrient content of diets (DM basis).

Item	Treatment ¹				
	CON	D10%	W10%	W20%	W30%
Ingredient					
Steam-flaked corn	84.50	74.50	74.00	64.50	54.50
Alfalfa	8.00	8.00	8.00	8.00	8.00
DDGS	---	10.00	---	---	---
WDGS	---	---	10.00	20.00	30.00
Pelleted supplement	7.50	7.50	7.50	7.50	7.50
Supplement Composition, % of DM					
Wheat middlings	13.59	64.02	64.08	68.92	73.56
Cottonseed meal	41.97	---	---	---	---
Urea	13.34	7.12	6.87	4.00	1.33
Limestone	19.54	20.39	20.39	20.24	20.06
Dicalcium phosphate	1.44	---	---	---	---
Potassium chloride	5.88	4.21	4.40	2.59	0.79
Salt	3.33	3.33	3.33	3.34	3.34
Trace mineral premix ²	0.33	0.33	0.33	0.33	0.33
Rumensin 80	0.25	0.25	0.25	0.25	0.25
Vitamin premix ³	0.17	0.17	0.17	0.17	0.17
Tylan 40	0.17	0.17	0.17	0.17	0.17
Thiamine ⁴	0.01	0.01	0.01	0.01	0.01
Nutrient Composition					
DM, %	83.13	84.06	73.17	65.34	59.02
CP, %	13.00	13.01	13.01	14.56	16.15
Ca, %	0.74	0.74	0.75	0.75	0.75
P, %	0.30	0.35	0.35	0.41	0.46
K, %	0.74	0.74	0.73	0.73	0.72
S, %	0.15	0.21	0.21	0.27	0.33
Fat, %	3.70	4.46	4.58	5.33	6.08
DIP, % of DM	7.92	6.75	6.89	6.95	7.04

¹Treatments were as follows: CON = control; D10% = 10% dried distiller's grains with solubles; W10% = 10% wet distiller's grains with solubles; W20% = 20% wet distiller's grains with solubles; and W30% = 30% wet distiller's grains with solubles.

²Contained 0.12% cobalt, 3.6% copper, 2% iron, 0.5% magnesium, 15% manganese, 0.132% selenium, 20% zinc, and 0.23% iodine.

³Contained 2,000,000 IU/lb vitamin A; 20,000,000 IU/lb vitamin D; and 50,000 IU/lb vitamin E.

⁴Formulated to provide 60 mg/hd/d.

Table 2. Effects of wet distiller's grains and dried distiller's grains on performance of feedlot steers.

	Treatment ¹					SE	TRT ²	Contrast ²		
	CON	D10%	W10%	W20%	W30%			D vs W	Linear	Quad
Body Weights, lb ³										
Initial	901.8	897.7	898.9	897.2	897.6	1.83	0.393			
d 28	1018.4	1024.8	1026.2	1014.1	1010.3	6.50	0.389			
d 56	1130.8	1136.1	1130.1	1113.6	1119.8	8.21	0.328			
d 84	1243.2	1248.8	1238.5	1217.5	1221.5	7.16	0.052	0.381	0.029	0.598
Final ⁴	1370.5	1381.5	1375.0	1347.5	1352.5	10.06	0.114	0.651	0.085	0.983
Adj. Final ⁵	1382.0	1374.8	1371.2	1348.6	1351.4	13.35	0.330			
ADG, lb										
d 0 to d 28	4.16	4.54	4.55	4.18	4.04	0.218	0.364			
d 0 to d 56	4.09	4.26	4.13	3.87	3.98	0.146	0.410			
d 0 to d 84	4.06	4.18	4.04	3.81	3.86	0.100	0.095	0.346	0.077	0.735
d 0 to end	3.85	3.96	3.90	3.69	3.74	0.082	0.154	0.641	0.141	0.972
Adj. d 0 to end ⁵	3.93	3.90	3.87	3.69	3.74	0.111	0.474			
DMI, lb/d										
d 0 to d 28	21.37	22.10	22.16	22.12	21.74	0.402	0.595			
d 0 to d 56	22.31	22.75	22.82	22.57	22.45	0.426	0.912			
d 0 to d 84	22.59	23.34	23.05	22.83	22.70	0.413	0.720			
d 0 to end	22.71	23.46	23.19	23.01	22.68	0.380	0.573			
F:G										
d 0 to d 28	5.17	4.94	4.89	5.43	5.41	0.215	0.272			
d 0 to d 56	5.47	5.38	5.55	5.87	5.65	0.148	0.218			
d 0 to d 84	5.57	5.60	5.71	6.00	5.88	0.089	0.010	0.410	0.005	0.168
d 0 to end	5.90	5.94	5.94	6.25	6.08	0.088	0.061	0.954	0.047	0.243
Adj. d 0 to end ⁵	5.79	6.03	6.00	6.25	6.09	0.152	0.324			

¹Treatments were as follows: CON = control; D10% = 10% dried distiller's grains with solubles; W10% = 10% wet distiller's grains with solubles; W20% = 20% wet distiller's grains with solubles; and W30% = 30% wet distiller's grains with solubles.

²Observed significance level for treatment and contrasts: D vs W = D10% vs W10%; Linear = Linear for WDGS treatments; Quad = Quadratic for WDSG treatments.

³Initial weight is presented with a 3% pencil shrink. All body weights after initial are presented with a 4% pencil shrink.

⁴Cattle were on feed an average of 123 d.

⁵Adjusted final weight was calculated from hot carcass weight divided by the average dressing percent (64.96%) of all the cattle after which ADG and F:G values were recalculated using the adjusted final weight.

Table 3. Carcass characteristics of steers fed wet distiller's grains and dried distiller's grains.

	Treatment ¹						Contrast ²			
	CON	D10%	W10%	W20%	W30%	SE	TRT ²	D vs W	Linear	Quad
Hot carcass weight, lb	897.8	893.1	890.8	876.0	877.9	8.67	0.330			
Dressing percent	65.5	64.6	64.8	65.1	64.8	0.37	0.502			
Fat thickness, in	0.53	0.50	0.51	0.54	0.52	0.029	0.874			
% KPH	2.36	2.48	2.15	2.36	2.46	0.094	0.146	0.022	0.235	0.121
LM area, in ²	14.24	14.10	14.62	13.59	13.70	0.289	0.121	0.218	0.053	0.648
Yield grade	3.15	3.13	2.91	3.30	3.27	0.143	0.347			
Marbling score ³	384	416	400	381	378	8.8	0.031	0.222	0.368	0.271
USDA choice, %	36.1	59.4	38.9	25.0	30.6	----	0.061	0.082	0.374	0.841

¹Treatments were as follows: CON = control; D10% = 10% dried distiller's grains with solubles; W10% = 10% wet distiller's grains with solubles; W20% = 20% wet distiller's grains with solubles; and W30% = 30% wet distiller's grains with solubles.

²Observed significance level for treatment and contrasts: D vs W = D10% vs W10%; Linear = Linear for WDGS treatments; Quad = Quadratic for WDSG treatments.

³Marbling score: 300 = slight; 400 = small.

Table 4. Effect of distiller's grains on net energy values of the diets.¹

	Treatment ²				
	CON	D10%	W10%	W20%	W30%
Diet NEm, Mcal/lb ³	0.957	0.948	0.947	0.916	0.936
Diet NEg, Mcal/lb ³	0.653	0.645	0.645	0.618	0.635
NE Values of Distiller's Grains					
NEm, Mcal/lb ⁴		0.910	0.900	0.801	0.939
NEg, Mcal/lb ⁴		0.621	0.620	0.527	0.643
NEm, % of SFC ⁵		86.3	86.5	77.0	90.2
NEg, % of SFC ⁶		86.3	86.1	73.2	89.3

¹Used following NEm and NEg values (Mcal/lb) for SFC, alfalfa and supplements:

SFC – 1.041 and 0.720

Alfalfa – 0.560 and 0.309

Control supplement – 0.427 and 0.272

D10% supplement – 0.489 and 0.291

W10% supplement - 0.489 and 0.291

W20% supplement – 0.526 and 0.313

W30% supplement – 0.562 and 0.334

²Treatments were as follows: CON = control; D10% = 10% dried distiller's grains with solubles; W10% = 10% wet distiller's grains with solubles; W20% = 20% wet distiller's grains with solubles; and W30% = 30% wet distiller's grains with solubles.

³Calculated based on actual performance and intakes using NRC equations.

⁴Example calculation: (Diet NEm of D10% - Diet NEm excluding DDGS)/level of DDGS in diet
 $(0.948 - 0.857)/0.1 = 0.910$

⁵NEm of distiller's grains/1.041 X 100

⁶NEg of distiller's grains/0.720 X 100

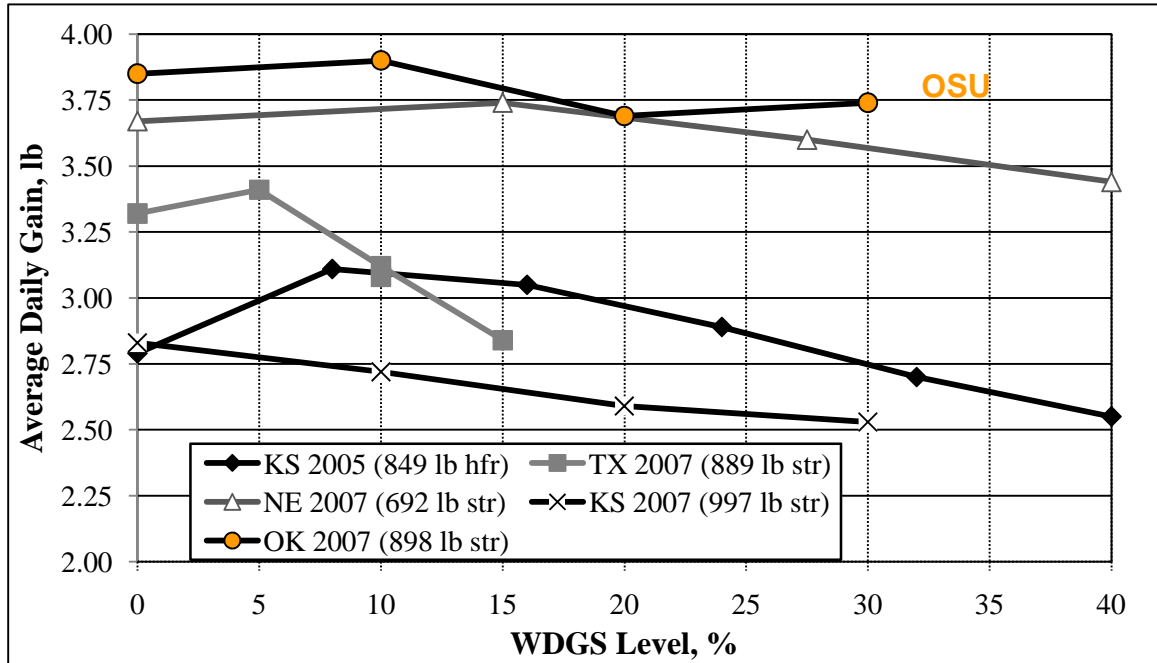


Figure 1. Effect of WDGS inclusion level on ADG in published research.

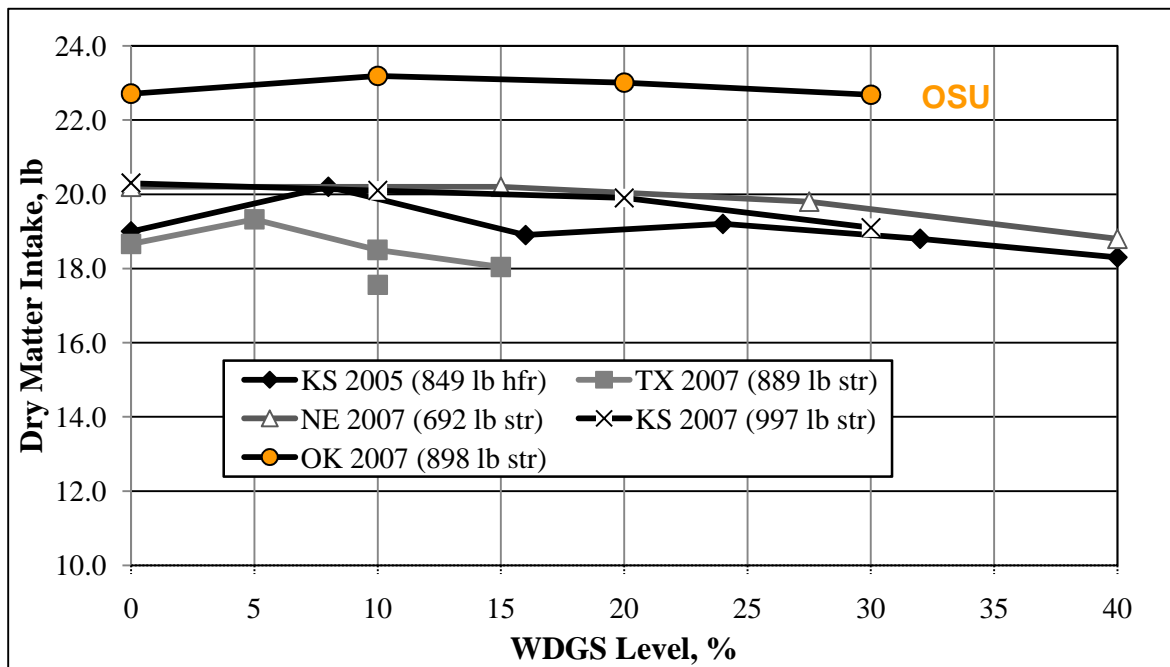


Figure 2. Effect of WDGS inclusion level on DMI in published research.

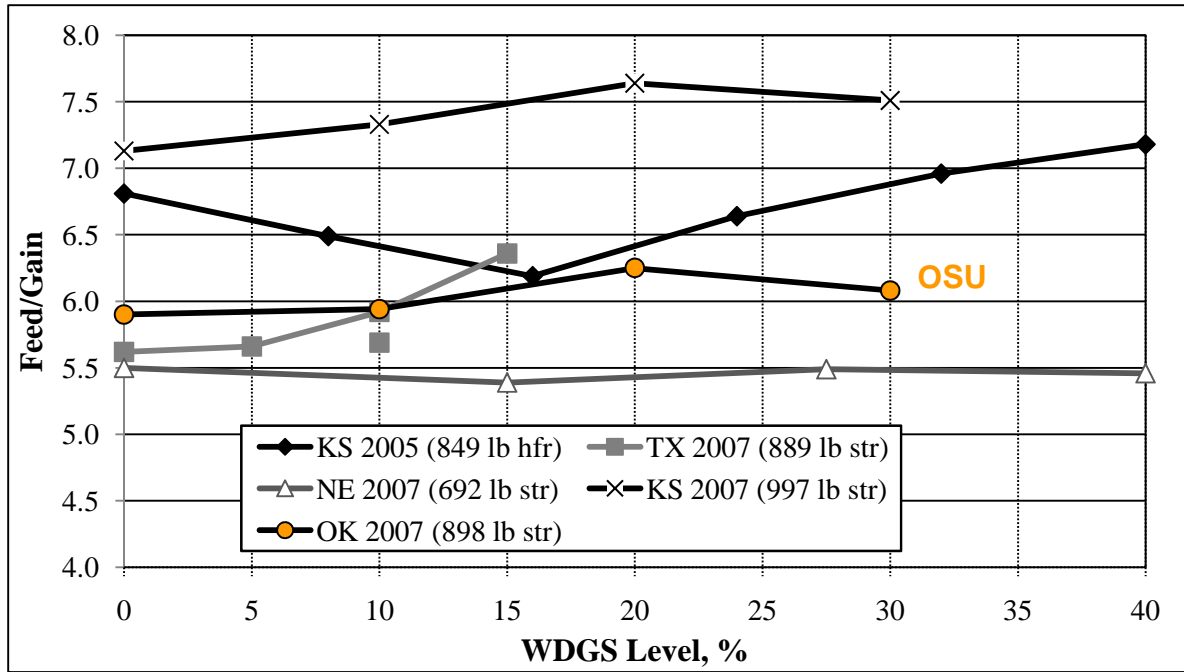


Figure 3. Effect of WDGs inclusion level on feed efficiency in published research.